

## **Methodology for the Puerto Rico Commonwealth and Municipio Population Estimates by Age and Sex (Vintage 2009): April 1, 2000 to July 1, 2009**

The U.S. Census Bureau produces annual estimates of the resident population for the Commonwealth of Puerto Rico and its municipios. The Commonwealth and municipio population estimates by age and sex were produced using a cohort-component method. The following documentation outlines the methodology used to produce the age-sex estimates for the Commonwealth and its municipios.

### **Overview**

The cohort component population estimation method follows each birth cohort according to its exposure to mortality, fertility, and migration. Starting with a Census 2000 base population tallied by age and sex, the population at each specific age is exposed to the chances of dying as determined by estimated or projected mortality levels and patterns by sex and age and controlled to equal the number of deaths reported from vital registration when available. Once deaths are estimated, they are subtracted from the population, and those surviving become older. For some years, births from vital registration are used directly. For other years, projected fertility rates are applied to the female population in childbearing ages to estimate the number of births. Each cohort of children is also followed through time by exposing it to mortality. Finally, the component method takes into account any in-migrants who come into the population and out-migrants who leave the population. Migrants are added to or subtracted from the population at each specific age-sex group. The basic components of the procedure we use to estimate the population are:

- (1) base population
- (2) plus births to Puerto Rico resident women
- (3) minus deaths to Puerto Rico residents
- (4) plus net migrants

The procedure is repeated for each year of the estimation period, by age and sex.

### **Method**

#### **Base Population**

The data by sex and single year of age (0-99 and 100+) for Census 2000 for the Commonwealth and its municipios with all Count Question Resolution and geographic program revisions were used as the base population. Each April 1, 2000 base population was moved to July 1, 2000 by applying the average intercensal growth rate between 1990 and 2000 for the Commonwealth and municipio as a whole to each age.

## Fertility

Births by age of mother for calendar years 2000–2008 for the Commonwealth and its municipios were taken from vital registration as received from the Puerto Rico Planning Board. These data were aggregated into 5-year age groups (from 15-19 to 45-49), with births reported to mothers under the age of 15 added to the 15-19 category, those over the age of 49 added to the 45-49 category, and those to women of unknown age distributed proportionally among each age group.<sup>1</sup> Age-specific fertility rates for 2009 were obtained by linearly interpolating between a pattern of age-specific fertility rates for 2008 (derived from the input births by age of mother and estimated population) and a pattern for 2050 based on historically observed age patterns in low fertility rate countries. Births for 2009 were obtained by multiplying the 2009 age-specific fertility rates by the midyear female population for 2009.

## Mortality

For the Commonwealth, deaths by age and sex for calendar years 2000-2008 were taken from the vital registration received from the Puerto Rico Planning Board. For the municipios, total deaths for each sex for calendar years 2000-2008 were taken from the vital registration as received from the Puerto Rico Planning Board. These data were provided in 5-year age groups except for the population under age 5, which for selected years were either provided for single ages 0 through 4 or for ages 0 and 1 to 4. Age-specific death rates for 2009 were obtained by linearly interpolating between the logs of age-sex specific death rates from the 1998-2000 Puerto Rico Commonwealth life table and those from a pattern for 2100 (based on the lowest death rates observed in low mortality countries through 1996). Deaths for 2009 were then estimated by multiplying the 2009 age-specific death rates by the estimated midyear population for 2009.

## Net Migration

We used net migration rates by sex and 5-year age group. These estimates were calculated from residual differences between a hypothetical population for April 1, 2000 and the Census 2000 enumerated population. The residual technique starts with the 1990 Census population and projects a hypothetical population for 2000 by accounting for changes due to fertility and mortality. This approximates what the 2000 population would be without migration, assuming similar errors of coverage in 1990 and 2000. Net migration for the 10-year period is estimated by subtracting the hypothetical 2000 population from the Census 2000 population. The net migration for the decade is converted to annual rates. These average annual net migration rates by sex and 5-year age group are assumed constant throughout the post-Census 2000 period.

## Resident Population Estimates by Age and Sex

The Census Bureau followed the above steps to produce initial annual estimates of the Commonwealth and its municipios resident population by single year of age and sex for July 1, 2001 to July 1, 2009. We derived the final municipio estimates by proportionately adjusting the

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<sup>1</sup> A relatively small number of births, whose municipio of residence was unknown, was distributed over all municipios in proportion to the reported geographic distribution of births.

annual estimates of each age-sex specific category so that the sum over all municipios was equal to the corresponding independently produced age-sex category estimate for the Puerto Rico Commonwealth. The total resident population estimate of each municipio was produced as the sum of its final age-sex population estimates.

### **Limitations**

A major limitation of the July 1, 2009 for the Commonwealth and its municipio estimates is the assumption that the migration in the post-Census 2000 period follows the same pattern as the migration for the 1990s estimated using the residual technique.

Estimates of net migration between 1990 and 2000 calculated with the residual technique are affected by differential coverage between the two censuses. To the degree that there are large differences in the 1990 Census coverage and Census 2000 coverage for Puerto Rico as a whole or for segments of the Puerto Rico population, the estimated net migration rates will be inaccurate.

Another potential limitation of the July 1, 2009 Commonwealth and its municipio estimates is the quality of the birth and death data. For the purposes of these estimates, it is assumed that these data are complete and accurate. However, there is no direct measure of the completeness of coverage of these measures.